

*State of California
The Resources Agency*

*Department of Water Resources
Northern District*

PROJECT REPORT
SACRAMENTO RIVER SPAWNING
GRAVEL RESTORATION PHASE I

Office Report

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FOREWORD

Anadromous fisheries in the Sacramento River Basin has suffered significant declines in the years since Shasta and Keswick Dam were completed in the 1940s. The reduction in fish populations are attributed to many causes including loss of spawning gravel habitat below Keswick Dam. One million cubic yards of spawning gravel are estimated to be needed to replace that loss.

During 1990 and 1991, the California Department of Water Resources placed 100,000 cubic yards of spawning gravel at eight locations in the 12 mile reach between Keswick Dam and Clear Creek. This is the first phase of a larger project to restore spawning habitat below the dams as described in the Upper Sacramento River Fisheries and Riparian Habitat Management Plan. This report describes the Phase I project.

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FIGURES

	<u>Page</u>
1 Upper Sacramento River Gravel Restoration Sites	5
2 Potential Upper Sacramento River Restoration Sites . .	12
3 Potential Upper Sacramento River Restoration Sites . .	13

TABLES

1 Quantities and Construction Contract Costs	6
2 Planning, Construction and Unit Costs for Spawning Gravel Restoration, Phase I	7
3 Potential Gravel Placement Sites Between ACID Dam and Cottonwood Creek	14
4 Construction Costs That Can be Partially Allocated to Future Projects	15
5 Right of Way Agreements Required for the 1990-91 Gravel Project	23
6 Regulatory Agency Permits for 1990-91 Project	24

CONTENTS

	<u>Page</u>
FOREWORD	iii
ORGANIZATION	iv
CHAPTER I. INTRODUCTION	1
History	1
Past Spawning Gravel Restoration Work	2
S. B. 1086 Fishery Restoration Planning Work	2
1990-91 Spawning Gravel Restoration Work	3
Phase II Planning Work	3
CHAPTER II. COMPLETION OF PHASE I WORK	4
Project Description	4
Cost of Phase I Project	6
Discussion of Phase I Work Critical Factors	7
Feasibility	7
Transportation of Gravel	8
Availability of Gravel	8
Cleanness of Gravel	8
Alternative Gravel Sources	9
CHAPTER III. PLANNING, DESIGN AND CONTRACT PREPARATION FOR PHASE II WORK	10
Environmental Documentation	10
Flood Analysis	10
Additional Sites	10
Right of Way, Permits, Specifications and Contracts	11
Completed Phase I Work That Will be Used During Phase II	15
APPENDIX A. PHASE I PROJECT DETAILS	17
Construction Work	17
Salt Creek Site	17
Diestelhorst Site	18
Market Street Site	18
Redding Riffle	19
Turtle Bay West Site	19
Turtle Bay East	19
Tobiasson Site	20
Shea Site	20
Gravel Processing	20
Pre-Project Planning	21
Right of Way	21
Permits	22
Environmental Documentation	24
Construction Contract and Specifications	25
Water Quality Monitoring Program	26

CHAPTER I. INTRODUCTION

Historically, the Sacramento River Basin has been one of the most prolific producers of salmon and steelhead in California. However, in the past 45 years, the fall and late fall chinook salmon runs have dropped to around 50 percent of their historic levels. The once predominant spring run is down to only a few hundred fish. The winter run chinook salmon have been reduced to an estimated 350 fish in 1991, less than one percent of their former numbers in the 1970s. As a result, this run was placed on the State endangered species list in 1989 and placed on the federal threatened species list in 1990.

Many factors are partially responsible for the decline of the Sacramento River fish runs. Some of these factors are the blockage of fish access to upper river habitat by Keswick Dam, fish passage problems at the Red Bluff Diversion Dam, predation of young migrating fish, high water temperatures, and loss of spawning gravel habitat below Keswick Dam.

During 1990 and 1991, the California Department of Water Resources performed work to replace spawning gravel in the Sacramento River in the Redding area. The following report describes the Spawning Gravel Restoration project.

This report is intended as both a progress report and a working reference for future projects. It begins with a short history and introduction. A general description and evaluation of the 1990-91 (Phase I) work follows the introduction. A section discussing future (Phase II) work is next. A detailed description of the 1990-91 project is included in Appendix A.

History

Shasta and Keswick dams, the core features of the Central Valley Project, were completed during the 1940s. Since then, the once extremely productive spawning and rearing habitat between Keswick Dam and Cottonwood Creek have experienced large-scale gravel degradation. These habitat losses are partly due to the blockage of stream gravel migration by the dams, and from a lowering of peak flows that have reduced stream bank erosion. Gravel mining, bank protection and levee construction have also contributed to this problem.

High flows have moved spawning-sized gravels downstream at an average rate of about one-half mile per year. This has left the upper 30 miles below Keswick Dam either deficient in spawning gravels or armored with 6 to 10 inch rock which is too large for successful spawning.

The loss of spawning habitat has contributed to the decline of all anadromous fish using this area. Most of the winter run spawning areas are in the upper river near Redding, where the

quantity of spawning gravels is low and the quality marginal. The few areas that contain suitable gravel and water velocity are overused and the nests of one race are frequently dug up by the next race.

Past Spawning Gravel Restoration Work

In 1978, the Department of Fish and Game placed about 2,300 yd³ of spawning gravel at two locations (Caldwell Park and Gasline Riffle). They also placed about 8,700 yd³ at the Redding Riffle in 1979, although most of this was washed downstream during flood flows shortly thereafter. Remnants of this gravel are still heavily used by spawning fish.

The Department of Water Resources in cooperation with Department of Fish and Game constructed a side channel spawning riffle in 1986 downstream from the Highway 299 bridge. This site was called Turtle Bay East, and is still used by spawning fish.

A similar project located upstream from the Highway 299 bridge was called Turtle Bay West. It was constructed by DFG in 1988.

There were two gravel restoration projects completed near Keswick Dam in 1988 and 1989. During 1988, DFG placed 16,000 cubic yards of gravel at the mouth of Salt Creek about one mile below Keswick Dam. The Salt Creek gravel has been closely monitored by the U. S. Fish and Wildlife Service. Most of the gravel has moved one-half mile downstream and all the way across the river bottom. It now provides a large area of good quality spawning habitat.

DFG also placed 8,000 cubic yards on the west bank just downstream of Keswick Dam in 1989. This gravel has not moved because flows have been unusually low since its placement. However, when it does move, the 25 percent white quartz tracer rock which composes part of the spawning gravel will aid greatly in tracking its movement. The Bureau of Reclamation funded both of these projects, which cost \$250,000 and \$200,000, respectively.

S.B. 1086 Fishery Restoration Planning Work

The "Upper Sacramento River Fisheries and Riparian Habitat Management Plan" (Resources Agency, January 1989)¹ authorized and funded by S.B. 1086 (Nielsen) addresses various Sacramento River anadromous fishery problems. The cost of the 20 restoration items described in the Plan is estimated to be approximately \$185,000,000.

¹ This plan was prepared in 1989 by the California Resources Agency in concert with 25 local agencies, recreation and environmental groups having expertise and responsibility on the Sacramento River.

Priority Item No. 3, of the restoration plan, is Spawning Gravel Restoration in the upper river. It recommends that 1,000,000 cubic yards of gravel be placed in the upper Sacramento River during a ten-year period. Federal legislation has been introduced during the last two years to authorize and fund the management plan.

1990-91 Phase I Spawning Gravel Restoration Work

In the interim, until legislation is passed, the Departments' of Water Resources and Fish and Game agreed to begin spawning gravel restoration work during the 1990-91 F.Y. Funding came from the 1986 Delta Pumps Fish Protection Agreement between DWR and DFG. This agreement was made to offset the direct fishery impacts of installing four additional pumps for the State Water Project in the southern Delta.

An advisory committee, referred to as the Delta Pumping Plant Fish Protection Advisory Committee, (Advisory Committee) was formed to recommend and approve expenditures from this fishery mitigation fund.

The Advisory Committee recommended placing 100,000 cubic yards of spawning gravel in the upper Sacramento River between Keswick Dam and Clear Creek in 1990-91. DWR's Northern District was assigned responsibility for doing the work. DWR began construction of Phase I of the spawning gravel replacement project in September of 1990. Work at all sites except Salt Creek was completed by March, 1991. Six thousand yd³ of gravel was stockpiled at the Salt Creek site was placed in the river in October 1991.

Phase II Planning Work

Planning for Phase II of the project, which involves placement of the remaining 900,000 cubic yards of spawning gravels in a longer reach of the upper river during a ten-year period was scheduled for completion by July 1992. This work was recently postponed indefinitely due to program budget cuts.

CHAPTER II. COMPLETION OF PHASE I WORK

Project Description

Spawning gravel was placed at 8 sites in the 12 mile reach of the Sacramento River between Clear Creek and Keswick Dam (Figure 1).

Gravel quantities and method of placement varied from site to site. The largest quantity was (24,330 yd³) placed at Salt Creek. The smallest quantity 1,240 yd³ was placed at the Diestelhorst Site.

Gravel was placed at the Salt Creek site by dumping it at the edge of the river and pushing it out into the current with a rubber-tired loader. The relatively high water velocities in the narrow channel immediately began moving gravel downstream.

Only 1,240 yd³ of gravel was spread in the river at the Diestelhorst Site, because Anderson-Cottonwood Irrigation District (ACID) believed gravel movement might adversely affect their diversion dam which is immediately downstream. ACID offered DWR access to their south shore island downstream from the diversion dam. DWR used this access to place about 11,080 yd³ at the Market Street site.

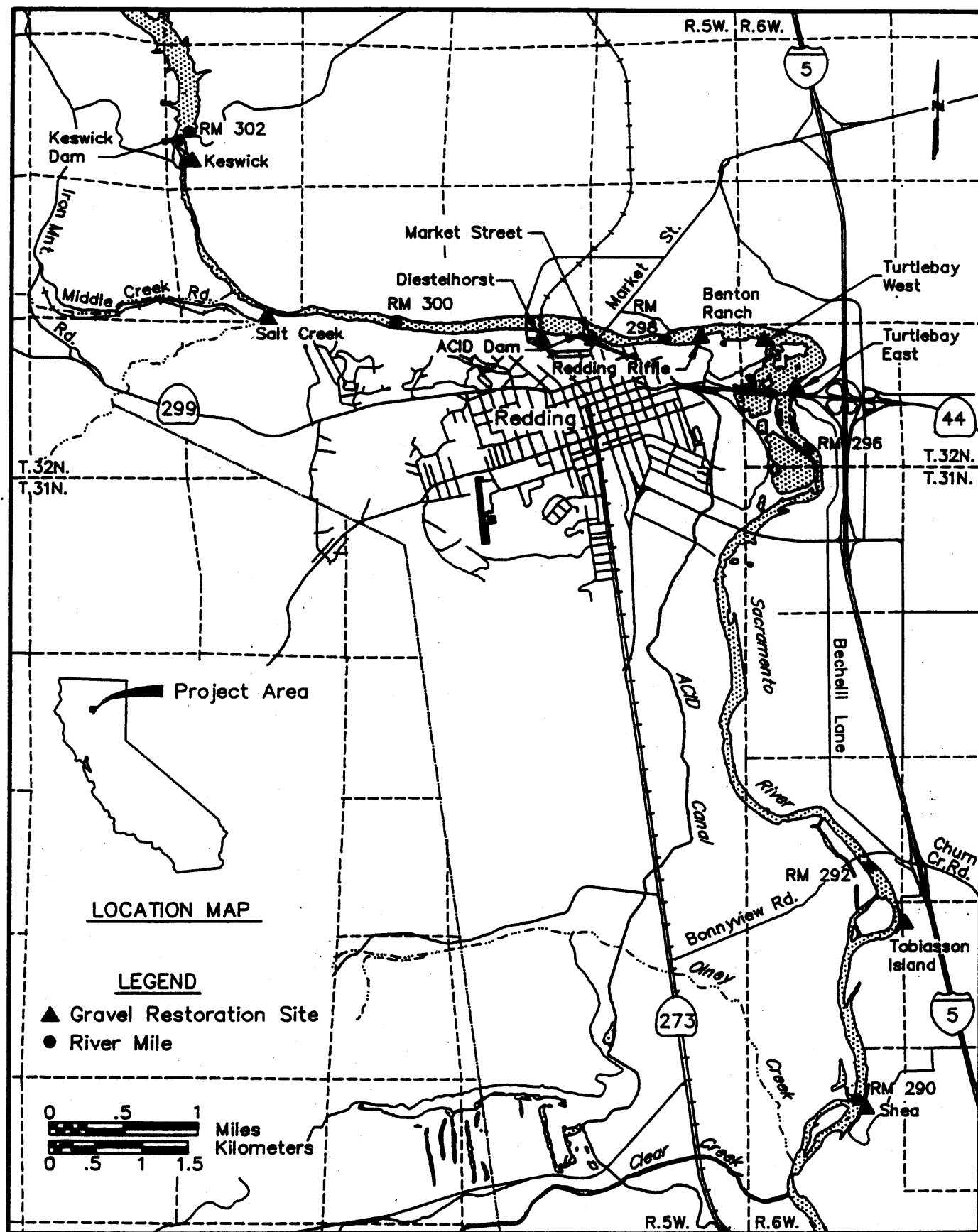
Gravel was placed along the riverbank at the Shea and Tobiasson sites. Gravel was dumped over the edge of a 10 to 12 foot high eroded bank. This material will remain in place until high flows begin to move it downstream.

White quartz tracer rock was included with gravel placed at the Market Street and Shea sites. U. S. Fish and Wildlife Service divers will use it to monitor movement during the next year.

Gravel at the remaining five sites was deposited in long low berms extending into the river. After the total planned gravel quantity was placed in the river at an individual site, a loader spread the gravel until the finished surface elevation was reached. This elevation was set lower than the level of the river at that site during a Keswick Dam flow release of 3,200 cfs. With the exception of Redding Riffle, almost all gravel was submerged during flow releases as low as 2,350 cfs, which occurred after gravel placement was completed.

The Department of Fish and Game has required two Cottonwood Creek Gravel Plants to provide DFG a percentage of 1" to 4" size gravel to mitigate for some of the environmental impacts of the gravel extraction. Approximately 14,225 tons (10,160 yd³) were stockpiled at the plants. The cost of washing, hauling and placing this gravel was included in the Phase I contract.

Figure 1



Upper Sacramento River Gravel Restoration Sites

Cost of Phase I Project

Table 1 Summarizes placement site quantities and construction costs.

Table 1
Quantities and Construction Contract Costs

Site	Placement Type	Quantity yd ³	Contract Construction Costs ² Dollars
Salt Creek	Bank	24,330	481,840
Diestelhorst	Underwater	1,240	32,674
Market Street	Underwater	11,080	194,834
Redding Riffle	Underwater	12,540	181,025
Turtle Bay West	Underwater	15,620	240,022
Turtle Bay East	Underwater	5,250	108,147
Tobiasson	Bank	12,450	195,591
Shea	Bank	17,730	291,385
Totals	----	100,240	1,725,518

The spawning gravel project cost \$2,162,384. This included \$436,866 for State expenditures and \$1,725,518 for the construction contractor's work. Planning, construction and unit costs for the project are shown in Table 2.

The bid price of spawning gravel delivered and placed at the sites was \$10.00 per ton, tracer rock \$21 per ton, and additional gravel transported to the Salt Creek Site under change orders was \$13.74 per ton.³ Access improvement work increased the computed gravel unit cost.

The contractor's bid price was also \$10.00 per ton for the gravel from the Cottonwood Creek plants that was provided to DFG.

² Contractor payment. Does not include any State costs.

³ The approximate bid price per yd³ was \$14.00 for spawning gravel, \$29.40 for tracer rock and \$19.24 for extra rock at Salt Creek.

Table 2
Planning, Construction and Unit Costs for
Spawning Gravel Restoration, Phase I

PLANNING	COST \$	Unit Cost \$/yd ³	Unit Cost \$/ton
Northern District	172,998	-----	-----
Right of Way	58,271	-----	-----
Specifications	23,910	-----	-----
Planning subtotal	255,179	2.55	1.82
CONSTRUCTION			
Contract Administration	38,478	-----	-----
Inspection	129,149	-----	-----
DWR Equipment	5,300(est)	-----	-----
DWR Revegetation	8,760(est)	-----	-----
Construction Contractor	1,725,518	-----	-----
Construction Subtotal	1,907,205	19.03	13.59
Total Project	2,162,384	21.58	15.41

Discussion of Phase I Work Critical Factors

The following items were of major concern during the planning and construction Phase and will continue to be critical during the Phase II work.

Feasibility

Phase I work was considered somewhat experimental. One objective was to determine if gravel placement on a large scale is effective, practical, and acceptable to river front property owners and recreation users. We were also concerned about transportation of gravel. Could enough hauling equipment and gravel sources be located to supply 100,000 yd³ in the relatively short construction time allowed? Would those trucks cause problems with the local transportation network? Would the city streets carry the loads? All of these potential problems were successfully resolved, although they did cause some concerns and modified work schedules at times.

Transportation of Gravel

The contractor used about 20 to 25 trucks per day to haul 120 to 150 loads. One day in January, he had 38 trucks to haul 261 loads (an average truck load carried about 23 tons (16 yd³) of gravel). Since the project was completed 15 days early, finding transportation for the quantities needed is not considered a limiting factor.

Little rainfall occurred during most of the hauling period so most city streets used for hauling did not deteriorate. The exception was a substandard section of Sunny Hill Lane leading to the Tobiasson site that began to deteriorate after heavy rains in early March.

The City of Redding restricted hauling on Bechelli Lane and at the Redding Civic Auditorium during special public events. The contractor was able to work around these restrictions with no apparent inefficiencies.

Availability of Gravel

Gravel plant processing capacity was the major limiting factor. Gravel was purchased from five plants. Forty-three percent of spawning gravel came from the Shea Plant on the Sacramento River across from Clear Creek. This plant had two screening lines running on double shift, but numerous breakdowns prevented them from supplying all of the gravel needed for the project.

Gravel was also hauled from two Cottonwood Creek plants; 29 percent was from the Anderson-Cottonwood Concrete Products Plant below the I-5 bridge and 17 percent from the Tenney Construction Plant. Neither of these plants could keep up with the contractor's gravel requirements.

The contractor also trucked seven percent of the gravel from the Thomes Creek Rock Plant three miles north of Corning and approximately 42 miles from the gravel placement sites. The white quartz tracer rock (four percent) came 170 miles from the Hanson Brothers Plant near Colfax.

At present, the greatest limiting factor for Phase II work seems to be the ability of nearby plants to produce enough gravel quickly from their existing supplies. This might be solved by awarding the bid several months before the gravel placement window begins so material could be processed in advance. If there are annual demands for large quantities of spawning gravel, the suppliers might invest in additional processing equipment.

Cleanness of Gravel

The California Regional Water Quality Control Board has jurisdiction for limiting pollutants in surface waters. The Board was willing to reduce some water quality requirements for

this project. However, even under the reduced standard, the modified limits were exceeded on 11 days.

There were several reasons for this. One was because turbidity was frequently not diluted by the main river flow 300 feet downstream where monitoring samples were taken. Samples taken further downstream tested much lower.

Another cause was gravel which was occasionally not as clean as specifications required. Efforts to track down the problem revealed that wash water from the end of screening lines was sometimes carrying small quantities of silt that would accumulate in the middle of the discharge pile. A solution may be an addition of a small deflector at the end of the conveyer line to direct this last rinse water away from the clean gravel discharge pile.

A third source was hard clay-like material found in the gravel from the Shea Plant. This material appeared similar to normal river run rock, but would shatter into fine clay particles when crushed by heavy equipment tires or sometimes by dumping into the river. These clay rocks cannot be eliminated by normal screening and washing procedures. If they are not crushed by hauling or placement, they don't cause a turbidity problem. However, gravel containing a low percentage of this material can produce significant turbidity and throw the entire stockpile out of specs. A possible solution is to use the Shea material only at the bank placement sites, so equipment crossing the gravel will be minimized.

Other minor problems were trucks that had remnants of dirt from previous loads in the bed, and dirt that was picked up from tires in loading trucks with gravel at the plants.

Alternative Gravel Sources

Some reviewers of our gravel restoration work believe that material from streams such as Cottonwood Creek that would normally provide gravel to the Sacramento River, should not be used for restoration work outside the creek's watershed. In response, we started investigating gravel sources from terraces located above active stream channels as part of our Phase II planning work.

Eventually, gravel suppliers will have to find additional out-of-channel supplies. Until then, they will still be selling gravel from creek channels for highways, concrete, asphalt, and other uses. The lead time necessary to develop new out-of-channel sources is considerable. Even when potential sites are located, there is usually extensive opposition by local interests such as agricultural and nearby residential owners. It is unlikely that we could perform the remaining gravel restoration work using entirely non-stream channel aggregate sources, but this possibility will be evaluated during the Phase II planning work.

CHAPTER III. PLANNING, DESIGN AND CONTRACT PREPARATION FOR PHASE II WORK

During Phase II of the Sacramento River Spawning Gravel Restoration Project, 900,000 yd³ of gravel is expected to be placed in the river during a ten-to-fifteen-year period. In order to place any additional gravel in the Sacramento River, several issues such as environmental impacts, flood level increases, and gravel sources must be resolved.

Environmental Documentation

Several control agencies accepted a negative declaration as an environmental document when they issued DWR permits to perform the first year gravel placement work. Phase II work will take many years to complete and will affect a much longer reach of the river. Therefore, these regulatory agencies believe a formal EIR/EIS should be prepared before starting Phase II. This will require about two years to complete and cost around \$200,000.

Flood Analysis

During Phase I consultation with Federal Emergency Management Agency (FEMA) engineers, we were advised to run the HEC-2 flood analysis model using modified Sacramento River cross-sections to represent the proposed gravel placements. This analysis indicated that the maximum post-project rise in the flood elevation would be 0.28 feet and that this level would decrease to about pre-project levels once this gravel was distributed downstream by high flows.

However, for the larger Phase II project, FEMA has requested a HEC-6 or Fluvial 12 sediment transport analysis model be run. We are conducting additional flood analysis studies, and working with FEMA to determine exactly what other work is needed to evaluate the potential flood impacts of gravel restoration work. We estimate this additional work will cost about \$250,000.

Additional Sites

Gravel was placed at eight sites between Keswick Dam and Clear Creek during Phase I work. Several additional sites will be used in the future.

A cursory review has located 21 potential sites between ACID Dam and Cottonwood Creek. Although some spawning occurs between Cottonwood Creek and Hamilton City, the upper reach was chosen for the following reasons:

The most significant loss of spawning habitat is below Keswick Dam. The water temperature above Cottonwood Creek is cooler, favoring survival of eggs and fry. Gravel placed in the upper watershed will replenish degraded habitat downstream as it moves during high flows.

Potential sites are shown on Figure 2 and 3. Table 3 provides details about the sites. Since access and right of way have not been investigated, a total quantity is not shown.

Right of Way, Permits, Specifications and Contracts

The construction specifications and contract is the legal document signed by the State and the contractor which governs the construction work and payment. Contractors must have specific information on locations, quantities, restrictions and method of placement before they can accurately calculate a bid price. The environmental documents, right of way, and regulatory agency permits must be obtained before completing the contract because they will affect what the contractor is allowed to do. Much of the planning and design process is concerned with developing this information.

Obtaining right of way requires the assistance of a professional land agent and can take from 3 to 6 months to obtain. For example, right of way for access under a Southern Pacific (SP) railroad trestle was difficult to obtain. After several months delay, SP finally responded to our request for R/W but required the contractor to provide a \$2,000,000 insurance policy. In addition, SP was very slow in processing permit applications. They had to be contacted several times.

Another right of way problem resulted from the need for a lease for construction of an access road on two property owners land. The process required a property survey before the leases could be negotiated.

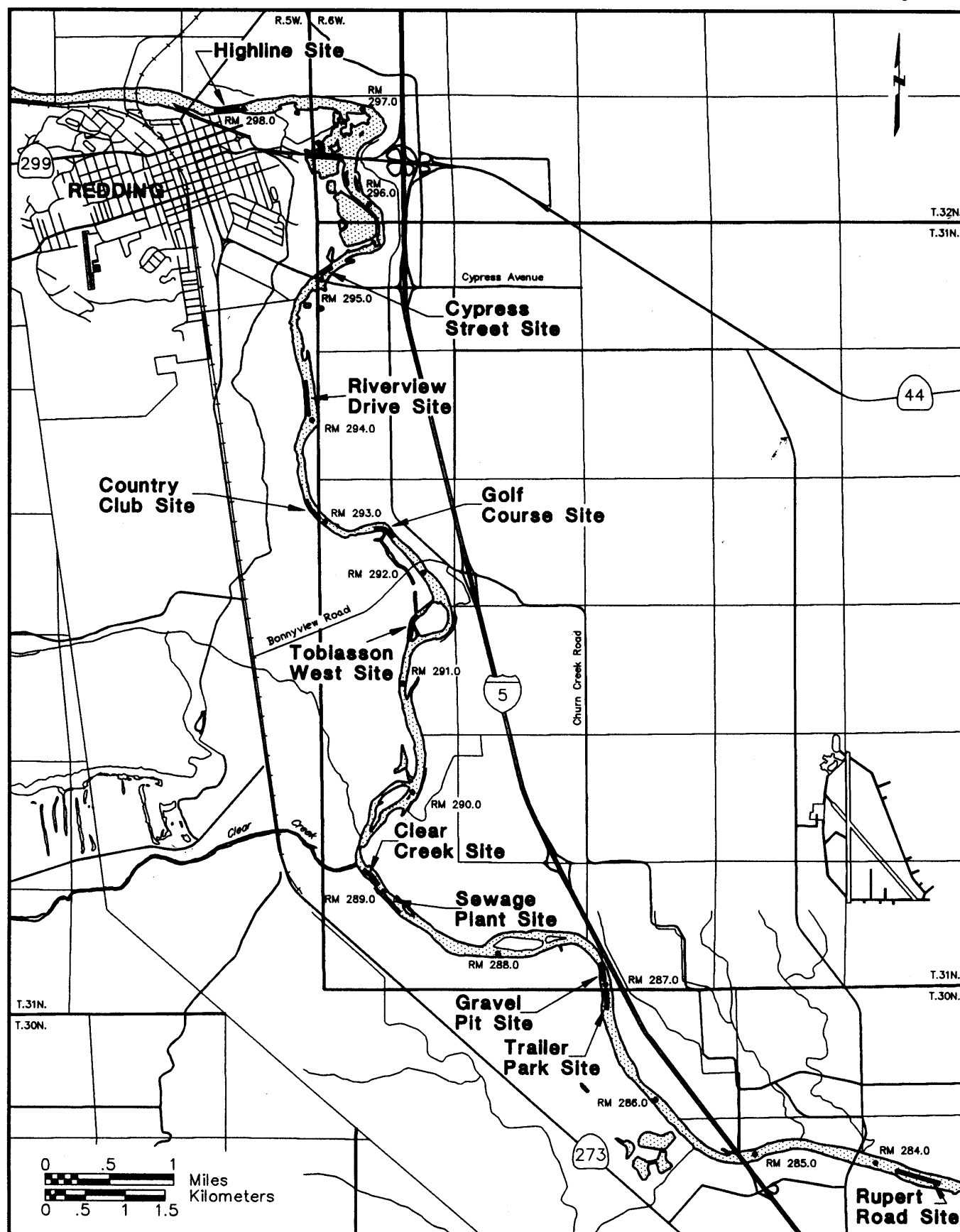
The City of Redding required an encroachment permit, which contained almost 50 conditions, and had to be reviewed and approved at two meetings of the city council. The council would only consider approval if the permit was formally placed on their meeting agenda.

The Anderson Cottonwood Irrigation District asked for testimony by our staff at several board meetings. They required legal review of the temporary entry permit we provided, charged us over \$100 for the review, and then delayed forwarding the document to their attorney.

Most regulatory agencies are now familiar with the project, so future permits may be easier to obtain. Some agencies have provided long-term permits, but others require site by site annual approval. A few require hearings before boards of directors, which may not meet frequently. Tables 5 and 6 in Section III lists the right of way and approvals from various agencies and individuals needed for Phase I work.

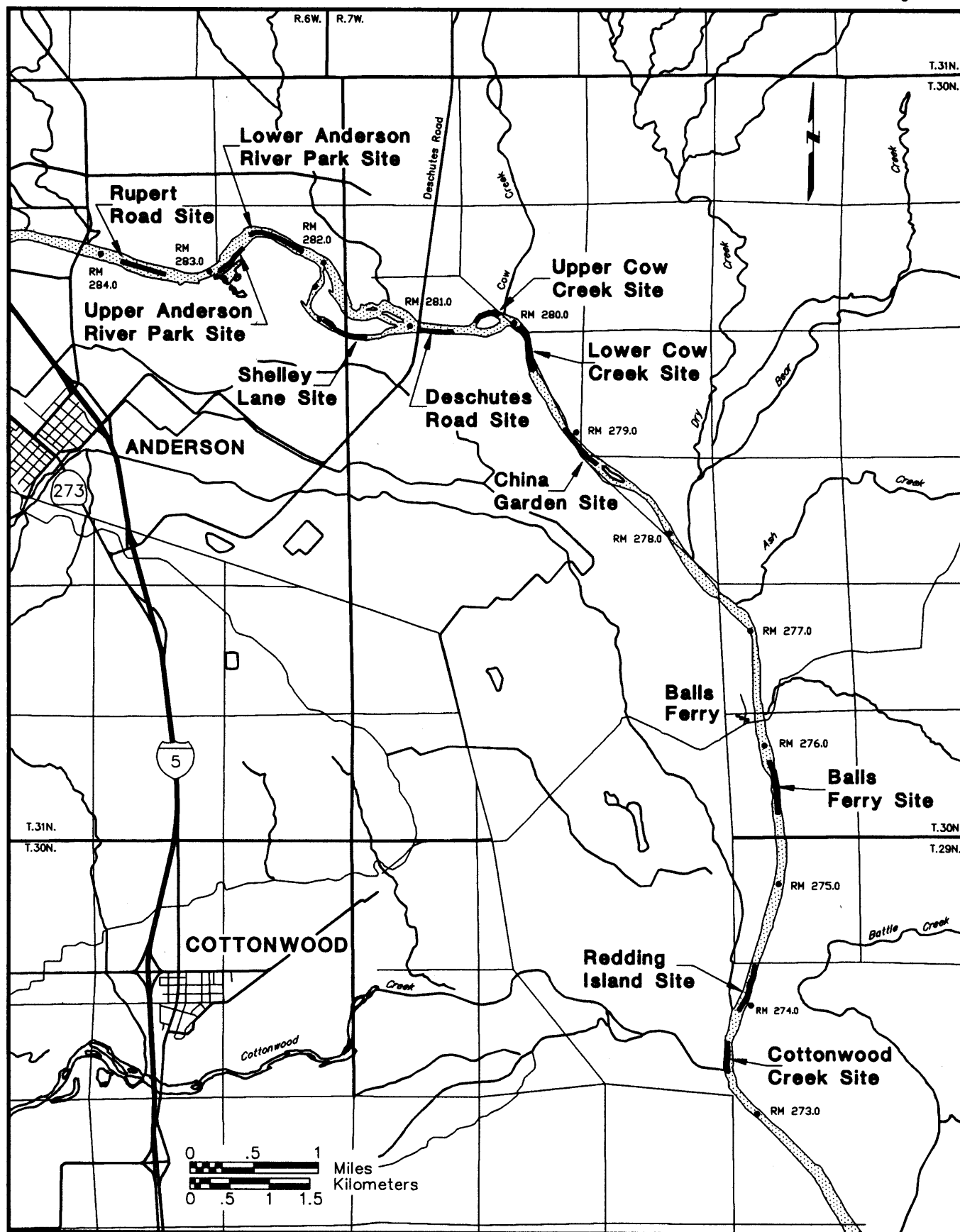
The construction specifications and contract awarded in 1990 can be used as a guide for future projects. The major changes will be in site descriptions and drawings. This will allow experienced specification writers to prepare new contracts fairly

Figure 2



Potential Upper Sacramento River Restoration Sites

Figure 3



Potential Upper Sacramento River Restoration Sites

TABLE 3
Potential Gravel Placement Sites
Between ACID Dam and Cottonwood Creek

Site	River Mile and Access Bank	Type of Placement	Access Ownership	Estimated Quantity yd ³
Highline	298.1 North	Channel	Public	20,000
Cypress Street	295.1 West	Channel	Public	7,500
River View Drive	294.1 West	Bank	Private	20,000
Country Club	293.1 West	Channel	Private	15,000
Golf Course	292.5 West	Channel	Private	15,000
Tobiasson West	291.4 West	Bank	Private	10,000
Clear Creek	289.2 East	Channel	Private	15,000
Sewage Plant	288.9 West	Bank	Public	10,000
Gravel Pit	287.3 South	Channel	Private	15,000
Trailer Park	287.0 West	Channel	Private	15,000
Rupert Road	283.5 North	Channel	Public	15,000
Upper Anderson River Park	282.8 South	Bank	Public	15,000
Lower Anderson River Park	282.6 North	Channel	Public	15,000
Shelley Lane	281.4 South	Channel	Public	10,000
Deschutes Road	280.9 South	Bank	Private	15,000
Upper Cow Creek	280.3 North	Channel	Private	15,000
Lower Cow Creek	279.8 East	Channel	Private	25,000
China Garden	279.0 West	Channel	Private	35,000
Balls Ferry	275.6 East	Bank	Private	20,000
Reading Island	274.1 East	Channel	Private	35,000
Cottonwood Creek	273.2 West	Bank	Private	20,000

quickly. However, new sites may require special designs for access that will increase the time needed to prepare the specs.

A minimum of six months should be allowed for permit application approvals, right of way, and contract writing. Then several more months will be needed to advertise and award the contract. At least nine months should be allowed between the date planning is completed, and the notice to begin work issued.

Completed Phase I Work That Will be Used During Phase II

Five placement sites required access work that can be used in future years. Access at other sites required no improvements. The following describes completed Phase I work that can be partially credited to future use. Table 4 lists the value of this work.

Table 4
Construction Costs That Can be
Partially Allocated to Future Projects

Site	Feature	Cost
Salt Creek	Connector Road, Road Surfacing, Gates, Trail crossing, Ballast removal	\$ 60,560
Diestelhorst	Road surfacing, Gates	\$ 10,375
Market Street	Road surfacing, Culvert	\$ 10,127
Turtle Bay East	Road surfacing, Gates, Culvert	\$ 22,615
Tobiasson	Road surfacing	\$ 17,215
Total Cost		\$ 120,892

Salt Creek needed the most extensive access work. This involved constructing a 300 foot access road to an abandoned railroad grade, removing the excess ballast rock from the grade surface, installing access control gates, and building a reinforced concrete truck crossing at the City of Redding's hiking trail.

The existing dirt road at the Diestelhorst site on the City of Redding's property needed surfacing with aggregate base rock so trucks could use it during inclement weather. In addition, the city required new gates to be installed.

The Market Street site also used the Diestelhorst access. The existing roadway on the ACID owned island was surfaced with aggregate base rock. A dirt ramp was constructed across the ACID Canal and removed at the end of work. A 36" culvert was salvaged from the ramp and can be used during future projects.

A truck return road was constructed at the Turtle Bay West Site. This road had to be removed, and gates installed because it is in an environmentally sensitive area. The cost of this construction cannot be applied to future projects.

Gates and access road work at Turtle Bay East are improvements that may be used again during future work.

The Tobiasson Site is located on private land. Nursery stock strawberry plants are raised there. An existing dirt road had to be surfaced to reduce dust that might affect the plants, and to provide a stable haul road during wet weather.

APPENDIX A

PHASE I PROJECT DETAILS

Although work completed during September 1990 and March 1991 has been summarized in previous sections, the detailed description that follows will provide information for planners and decision makers.

This section describes the work done at each placement site; gravel processing; pre-project planning work, including right of way, regulatory agency permits, environmental documentation, the construction contract and specifications; and water quality monitoring.

Construction Work

Nordic Industries Inc., located in Marysville, California, was the low bidder. They received the notice to proceed on September 5, 1990 and began work at Salt Creek on September 12. The contractor's work was completed on March 8, 1991.

The following section describes work done at each site.

Salt Creek Site

Truck access to the Salt Creek site required construction of a connector road from Middle Creek Road to an abandoned section of railroad grade. The contractor used a bulldozer, sheep foot roller, smooth roller, motor grader and water truck to excavate a cut for part of the connector road. Cut spoil was placed and compacted as fill near the RR grade. Aggregate base rock was hauled in and compacted for a road wear surface.

Rails and ties had previously been removed from the railroad grade but a layer of ballast rock remained. This rock was angular with sharp edges, and even after removal, remnants still caused damage to the tires of load trucks. The railroad ballast rock was removed from the road surface using a paddle wheel scraper, a rubber tired front end loader and a motor grader to haul or push the material into windrows along cut banks. The U.S. Bureau of Reclamation owns the grade and will use this excess material for projects elsewhere.

The City of Redding required a permanent truck crossing at their paved hiking trail. A reinforced concrete pad was constructed at the crossing. The City and USBR both required gates to control vehicle access to their properties. These were installed at three locations.

After access work was completed, the contractor began hauling gravel to the river. Trucks were backed up to the bank and dumped along the edge. A rubber tired 5 yd³ front end loader pushed the gravel into the river. As material was deposited in the river, trucks could be backed further out. Eventually, a

gravel terrace about 300 feet long extended over half way across the channel.

Along the edge of this terrace gravel began to be washed away soon after being deposited. Even though flow released at Keswick dam was only about 3,800 cfs, the velocity through the project area was high enough to erode the gravel terrace.

During September 1990, 17,980 yd³ of gravel was placed in the river at Salt Creek. An additional 6,350 yd³ of gravel was stockpiled on the bank during March 1991. This additional material was placed in the river by DWR equipment operators during September and October of 1991.

Diestelhorst Site

The Diestelhorst Site was originally planned to be a major placement site. The Anderson Cottonwood Irrigation District was concerned about effects of gravel movement on their diversion dam. They volunteered access to their property downstream of the dam if the quantity of gravel placed immediately upstream would be greatly reduced. Therefore, only about 1,240 yd³ was placed at the Diestelhorst site.

Market Street Site

The Market Street site is next to an island owned by ACID which separates the river from the canal entrance. This island extends above and below the Market Street Bridge. Equipment access to the island is from a gravel bar that is exposed from October through March after ACID removes the boards from their Diversion Dam.

A road bed was graded on the bar from the Diestelhorst site to the diversion canal. At the canal, a ramp was constructed from gravel bar material up the bank to the island. A 30-inch culvert was placed in the canal under the ramp to insure that fish in the diversion channel would not be dewatered.

The existing island road was widened and surfaced with aggregate base. Ramps were constructed off the islands north edge to the water at three locations. Construction included removing 30-foot wide strips of riparian vegetation at each ramp.

Gravel placement was done from all three ramps. Trucks were backed down the ramps and dumped. The loader spread the material, building a causeway down the river. Eventually all ramps were connected and trucks could make a loop as they dumped.

When enough gravel was placed in the causeway, loaders spread the gravel until it was all under water. Then tracer rock that had been stockpiled on the bar near the Diversion Dam was spread over the spawning gravel.

To finish, the ACID canal crossing ramp was removed, and the culvert was salvaged and stored for future use.

Redding Riffle

The City of Redding permitted stockpiling of processed gravel near the Redding Riffle. This allowed the contractor to process and stockpile about 2,900 yd³ of gravel during the October 15 through December 31 period when the placement window was closed.

The Redding Riffle site was another in-water dump and spread operation. Water depths were shallow, so the material was spread over a wide area. Placement of the material was done in January. Access required moving some concrete parking bumpers and logs. Traffic control was necessary on the road around the civic auditorium. The contractor had to fix some minor damage to pavement and water boxes caused by his trucks.

During March, after the USBR reduced flows to 2,300 CFS almost all gravel was exposed. Fortunately, no fish had spawned here before water levels were lowered.

Turtle Bay West Site

Turtle Bay West is located on city property in an area reserved as a bird sanctuary. Existing or abandoned roads were used for access. The contractor improved an abandoned road as a return loop road. This work inadvertently was not discussed in DWR's negotiations with the local Audubon Society or the city. Therefore, the loop road was removed after hauling was completed. Gates and berms were installed, and the route planted with grasses and shrubs. The loop road will not be used during future projects.

Gravel placement was accomplished in February. A causeway of gravel was constructed out into the channel, then upstream from a single ramp location. The ramp site did not require removal of any vegetation. The causeway was about 800 feet long.

Water depths ranged from 8 to 10 feet before the ramp was built. Spreading was done very quickly, because the gravel needed to be moved only a short distance before reaching the desired water depth. At the 2,300 cfs releases, all the gravel was still under water.

Turtle Bay East

This site is on city land which is designated as a bird refuge. Access work was required to improve an existing road near the bluffs east of the river, and to control vehicle access into the area with barricade fences and gates. In addition, a 36-inch culvert was installed under the access road to the site.

The only access is by Bechelli Lane which is a city residential street in this area. This street is considered to be of

substandard construction for use by loaded trucks and passes through a neighborhood of expensive homes. Therefore, the city limited gravel hauling to 5,000 yd³ during the months of September and October. No hauling was allowed during wet weather.

These conditions meant that the access road work, gravel hauling, and stockpiling had to be completed by the end of October. Then the contractor had to place the stockpiled gravel in the river during the January-March window. However, when additional funds were released for the project, no additional gravel could be hauled in. This site could beneficially accept several times the gravel quantity installed.

Tobiasson Site

The Tobiasson Site was deleted from the contract after the engineer's estimate indicated there was not enough funds available for all work proposed by the Advisory Committee. It was reinstated by a Change Order when additional money was made available.

Access required surfacing about 1,200 feet of one lane dirt road with aggregate base rock. Trucks dumped spawning gravel at the top of the eroded river bank and a front end loader pushed it off the bank. Gravel covered about 700 lineal feet of bank approximately 12 feet high. Placement required no vegetation removal, although a few patches of grass and shrubs were covered by gravel. Work began in February and ended in March.

The channel at the Tobiasson site is narrower than at the Shea site, so gravel will probably begin moving at lower flows. Normal summer flow releases are not expected to move the material.

Shea Site

A third bank placement site is at the Shea Sand and Gravel Plant upstream from the Mouth of Clear Creek. This site required only smoothing of the top of the bank for stockpiling Quartz Tracer rock.

Tracer rock was stockpiled during November and December 1990. Spawning gravel was placed along 1,100 feet of bank in February 1991. The method used was the same as at the Tobiasson Site. The tracer rock was placed last, along the outer slope. When high water moves the gravel, the tracer rock is expected to mix with the spawning gravel. A few bushes growing in the eroded bank were covered by gravel placement.

Gravel Processing

Gravel plant operators had little difficulty meeting gradation specifications for spawning gravel. However, the maximum size specification for white quartz tracer rock was reduced to three

inches because larger sizes were not available. The gradation specifications for spawning gravel and tracer rock were as follows._

<u>Spawning Gravel</u>		<u>Tracer Rock</u>	
Sieve Size	Percent Passing	Sieve Size	Percent Passing
4 inch	100	3 inch	100
2 inch	65-75	1 inch	0-5
1/2	0-5	No. 4	0-1
No 4	0-1		

A high cleanness value of 85 was specified for spawning gravel. (In comparison, Caltrans specifications require concrete aggregate to have a cleanness value of 83). To meet this standard, plant operators installed additional washing devices on their screening lines. The Department assigned individual inspectors to each plant. Even with these actions, some gravel did not meet specifications when delivered to sites.

Quartz Tracer rock was specified for placement at the Market Street and Shea Sites. This rock is to aid USFWS divers in tracing gravel movement. This rock had to be hauled from Colfax and was about 2-1/2 times as expensive as locally available spawning gravel.

Pre-project Planning

DWR consulted with various fishery agencies to determine design criteria for placement. They agreed that gravel should be submerged at Keswick flow releases of 3,200 cfs⁴. They suggested some sites were better for placing material along an eroding bank such as the Salt Creek, Shea and Toblason Sites, At the others, the gravel should be spread out in the river, away from shallow bank habitat that is critical to fry.

Fishery agencies also determined the time periods that restoration work would have the least impact on the four fish runs in the Sacramento River. These periods were from September 1 through November 15 for bank placement sites, and from January 1 through March 31 for underwater spreading sites.

Right of Way

Work to secure access rights for the Project began in March 1990. Sites on public property required encroachment permits from agencies. Access to private property was usually obtained with a Temporary Entry Permit signed by property owners and their tenants. The Northern District began this work, which was finalized by the

⁴ In March 1991, the USBR reduced Keswick Dam flow releases to about 2,300 cfs. This was about 900 cfs under the designed flow for the riffles. With the exception of the Redding Riffle, a portion of the Market Street site, and the bank placement sites, all the placed gravel was submerged at this flow.

Land and Right of Way staff of the Division of Design and Construction in Sacramento.

One owner at the Salt Creek access wanted a lease for rights to construct the connector road across a corner of his land. This lease required surveying property lines to determine the exact area required in the lease.

Table 5 lists the right of way agreements needed for this project.

Permits

Applications for regulatory agency permits were prepared in April and May 1990. Since these applications required specific site information and gravel qualities, they could not be submitted until the proposed sites were approved by the Advisory Committee. Issuance of the permit then required from one to four months. Permits needed for Phase I are described below.

The California Department of Fish and Game issues a "Streambed Alteration" permit for any work that affects waterways of the State. The "1601" permit was processed by DFG in just a few weeks.

The State Reclamation Board has jurisdiction for all works or uses that encroach into rivers and waterways contained by federal and State authorized flood control projects, and within designated floodways. Board permits are site specific, but do not have a termination date unless revoked by the agency. The 1990 permit specified work at nine sites. Additional sites will require a new application.

The State Lands Commission is responsible for most lands located in waterways below the normal high water line. They normally require site specific applications. The Commission may require documenting where the State lands lie, usually by title search and surveys.

However, under a 1979 agreement titled, Memorandum Of Understanding between the State Lands Commission and the Department of Water Resources for the Use of State Lands for Facilities of the Central Valley Project and the State Water Resources Development System, submitting a ninety-day notice of proposed work to the commission is acceptable. This notice procedure was used for the 1990-91 work. Future work will require another 90 day prior notification.

A State Lands Commission regional permit had been issued to DFG for previous gravel restoration work. This permit expired in 1989. DFG applied for another permit, and was issued site specific leases. If future work is done without DWR participation, these leases can be used by DFG.

Table 5

**Right of Way Agreements Required
for the 1990-91 Gravel Project**

Site	Owner	Type of Agreement	Term
Salt Creek	US Bureau of Reclamation	Access road Permit	October, 2000
	City of Redding	Encroachment Permit	April, 1991
	Shasta County	Encroachment Permit, Hauling Permit	June, 1991
	Ayres	Right of Entry Lease	Pending
	Ottaviano	Right of Entry Lease	July, 1995
Diestelhorst	City of Redding	Encroachment Permit	April, 1991
	CalTrans	Encroachment Permit	July, 1992
	Southern Pacific Transportation Co.	Right of entry for Contractor, \$2M insurance	October, 1991
Market Street	City of Redding	Encroachment Permit	April, 1991
	Anderson Cottonwood I.D.	Temporary Entry Permit	October, 1991
	CalTrans	Encroachment Permit	July, 1992
	Southern Pacific Transportation Co.	Right of entry for Contractor, \$2M insurance	October, 1991
Redding Riffle	City of Redding	Encroachment Permit	April, 1991
Turtle Bay W.	City of Redding	Encroachment Permit	April, 1991
Turtle Bay E.	City of Redding	Encroachment Permit	April, 1991
	CalTrans	Encroachment Permit	July, 1992
Tobiasson	Miyasaka, West	Temporary Entry Permit	June, 1991
Shea	Smith, Shea	Temporary Entry Permit	May, 1991
Anderson-Cottonwood Concrete Products Plant	Shea	Temporary Entry Permit	September, 1991
Tenney Construction Concrete Plant	Tenney	Temporary Entry Permit	September, 1991
J. F. Shea, Inc Plant	Shea	Temporary Entry Permit	September, 1991

During 1988, DFG applied to the Corps' of Engineers for a Permit to place fill at spawning areas in the San Joaquin-Sacramento River drainage. The Corps' issued the State of California a five year General Permit which allowed any State agency to do this work. USCE had to confirm the work was within the provisions of the general permit. This required DWR to submit letters and application forms, and for USCE staff to visit the sites. The general permit will require renewal in 1992.

The California Regional Water Quality Control Board issued a Wavier of Waste Discharge Requirements for the project. They imposed turbidity and settleable matter limits and required monitoring 300' downstream from the gravel placement work.

The following table lists regulatory agency permits needed for the project.

Table 6
Regulatory Agency Permits for 1990-91 Project

Agency	Permit	Term	Remarks
Dept of Fish and Game	1601 Permit	December, 1990	
Reclamation Board	Permit #15495GM	Until revoked	Site Specific
State Lands Commission	Memorandum of Understanding	Not limited	MOU for CVP and SWP related work
U. S. Army Corps of Engineers	General Permit No. 008	August, 1993	For fill in spawning areas, Sacramento-San Joaquin Rivers and tributaries
Water Quality Control Board	Waver of Discharge Requirements	March, 1991	Requires monitoring and limits turbidity and settleable matter

Environmental Documentation

The Phase I project falls under jurisdiction of the California Environmental Quality Act (CEQA). CEQA guidelines recommends an Initial Study to determine if there are any potential negative environmental effects which may result from the work. CEQA also requires either preparation of a negative declaration or an Environmental Impact Report.

We performed an Initial Study using the CEQA Environmental Impacts Checklist as a guide. This initial study concluded:

1. Gravel will be obtained from commercial suppliers, so no new pits will be opened.
2. Existing river access roads will be used at all sites.

Construction of a short (300 foot) access road to an abandoned railroad grade leading to the Salt Creek site will be required. Several narrow access points will be cut through riparian vegetation at the water's edge. This work will be fully mitigated and, therefore, it was not judged significant.

3. No significantly increased flood hazard will occur.
4. Additional Phase II gravel restoration work after placement of the first 100,000 cubic yards will not be performed until after preparation of a full EIR/EIS.

When the Initial Study was completed, a Negative Declaration was prepared and both were sent to the State Clearinghouse for a 30 day public review (SCH #90030390). A notice advertising the availability of the negative declaration was published in the Redding Record Searchlight newspaper.

No comments were received during the review period; so the Negative Declaration was approved by the Department. A Notice of Determination was then filed with the Secretary of Resources and the Shasta County Clerk.

Construction Contract and Specifications

As originally planned, the Phase I project was to use Northern District contracts for different parts of the work. When planning for the project became more defined, we concluded that a single construction contract should be used. Since DWRs Division of Design and Construction has the expertise for preparing and administering construction contracts, they were asked to do this portion of the work. The Northern District provided a contract draft and drawings to the D&C specification writers. They, in turn, completed the final contract, and did the necessary advertising.

Because of the restricted time periods available for placing gravel in the river, the normal D&C contract advertising and approval period would have taken too long to complete. Therefore, the Northern District asked for permission to solicit informal bids under provisions of the Public Contract Code. This saved several months, and allowed the contractor to begin work in September 1990.

The Contract⁵ was advertised for placing 64,750 tons (46,250 yd³) of spawning gravel at seven sites. This bid quantity was determined by the amount of funds available as proposed by the steering committee. In early 1991, the committee decided that the original proposed quantity of 100,000 yd³ of gravel was

⁵ Specification No. 90-37, Contract No. C50906, Gravel Restoration - Phase I, Sacramento River Mile 290 to 302.

needed, and that funds were available to pay for the work. As a result, gravel quantities were increase at most sites, and a previously deleted bank placement site was added to the contract. (Tracer rock quantities were not increased.)

Since the DFG placement window time period had passed for the Salt Creek Site, the additional material was stockpiled on the bank for later placement in the river. At the Turtle Bay East Site, no additional gravel could be placed because the City of Redding encroachment permit only allowed hauling on north Bechelli Lane during September and October.

During construction, Northern District inspectors collected truck weight slips, and other information, tabulated them and submitted originals and summaries to D&C Project Headquarters in Sacramento. Project HQ then processed payment to the contractor.

Water Quality Monitoring Program

The Regional Water Quality Control Board issued a Waiver of Waste Discharge Requirements for the project. This set turbidity and settleable matter limits and required DWR to conduct a monitoring and testing program at each placement site.

The Waiver included the following criteria:

Material placed in the river shall consist only of clean (washed) rock or gravel.

Maximum increase in turbidity of 15 Nephelometric Turbidity Units (NTU) above background levels as measured 300 feet below the work.

Settleable matter limited to 0.1 ml/l as measured 300 feet below the work.

All samples shall be collected in the turbidity plume and be representative of worst conditions which exist in the receiving waters.

No visible oil, grease, scum, or foam in the river.

Sampling was usually done twice a day. DWR inspectors collected samples at periods when turbidity was observed to be at a high level, a "worst case" sample. If conditions changed, additional samples were taken.

A 10-foot sampling rod was used to position one-half gallon plastic bottles in flowing water 300 foot upstream and downstream from the work location. Sample depths varied from several feet under the surface to about one-half the total depth in shallow water.

The sample taken 300 feet upstream provided a background value. A second sample was then taken 300 feet downstream. Depending on the site, the sample locations were at least 15 feet from the

bank. Use of rock outcrops, or wading in shallow water aided getting samples from the turbidity plume.

On occasion, a jet boat was used to sample in deeper water, but usually a representative sample could be acquired from near the bank because the current tended to concentrate turbid flows there.

Sample bottles were delivered daily to the DWR office laboratory in Red Bluff. DWR staff measured turbidity and suspended solids. The data were tabulated in a monthly report sent to the Board.

The board was notified by telephone when turbidity was high, for example, when spreading out gravel placed earlier in the river. Lab testing results for these periods were also telephoned to them on the next business day.

In response to several days when turbidity was higher than allowed, the board asked DFG staff to advise us about ways to reduce the negative effects of the gravel placement on water quality.

DFG suggested we try to keep turbid waters concentrated near one bank, and to spread material as quickly as we could to reduce the time that downstream turbidity would be high. They also suggested additional sampling further downstream where the turbidity plume was more dissipated.

This was tried at the Turtle Bay West site where samples were gathered from the center of the channel at several downstream locations for comparison to the regular samples. As expected, turbidity values were considerably lower after the turbidity plume mixed with the entire flow of the river.